Synergy: Building Information Modeling and Lean Construction

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BIM Handbook Symposium

Georgia Tech

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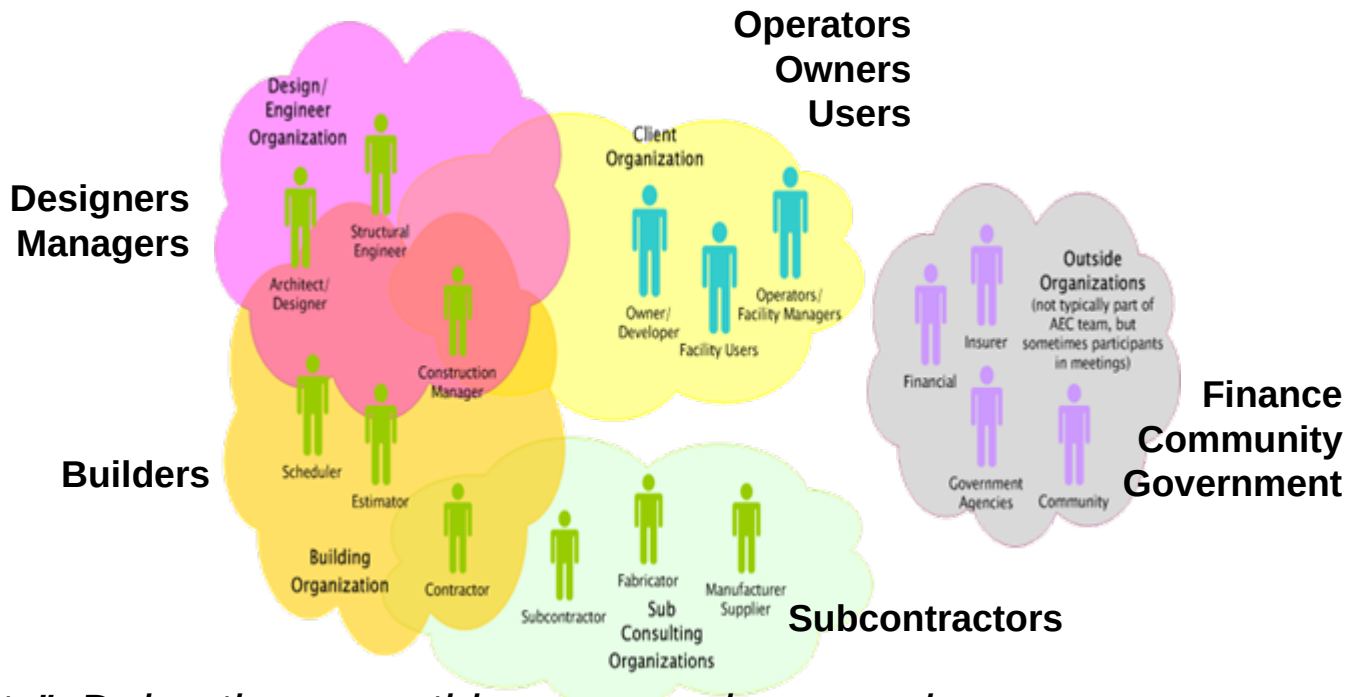
Introduction

- Both Lean and BIM are deep **process changes**, in thinking and in practices. Both require concerted **long-term efforts**, within **stable business and work environments**



"Insanity": Doing the same thing over and over and expecting a different result" (Albert Einstein)

What is Lean Construction?

The Lean Construction Vision:

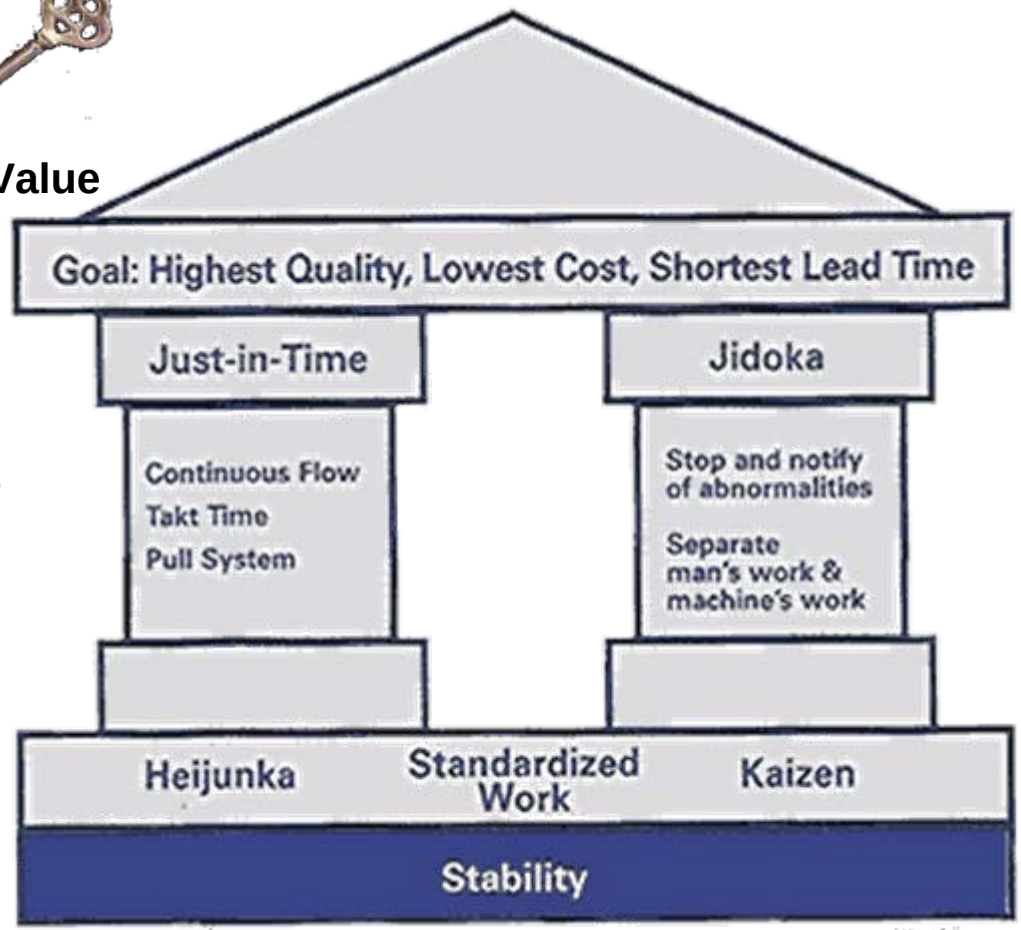
- *….**new principles and methods for product development and production management specifically tailored to the AEC industry,** but **akin to those defining lean production** that proved to be so successful in manufacturing.*

(from www.iglc.net)

- ***Value** - to better meet **customer demands***
- ***Flow - AEC process** as well as **AEC product***
- *Remove **Waste***
- *applies to **design, detailing, supply** and **construction***

AEC = Architecture, Engineering, Construction

Toyota Production System



Toyota Production System "House"

Value

Remove Waste (Muda)

Continuous Flow

Error-free work

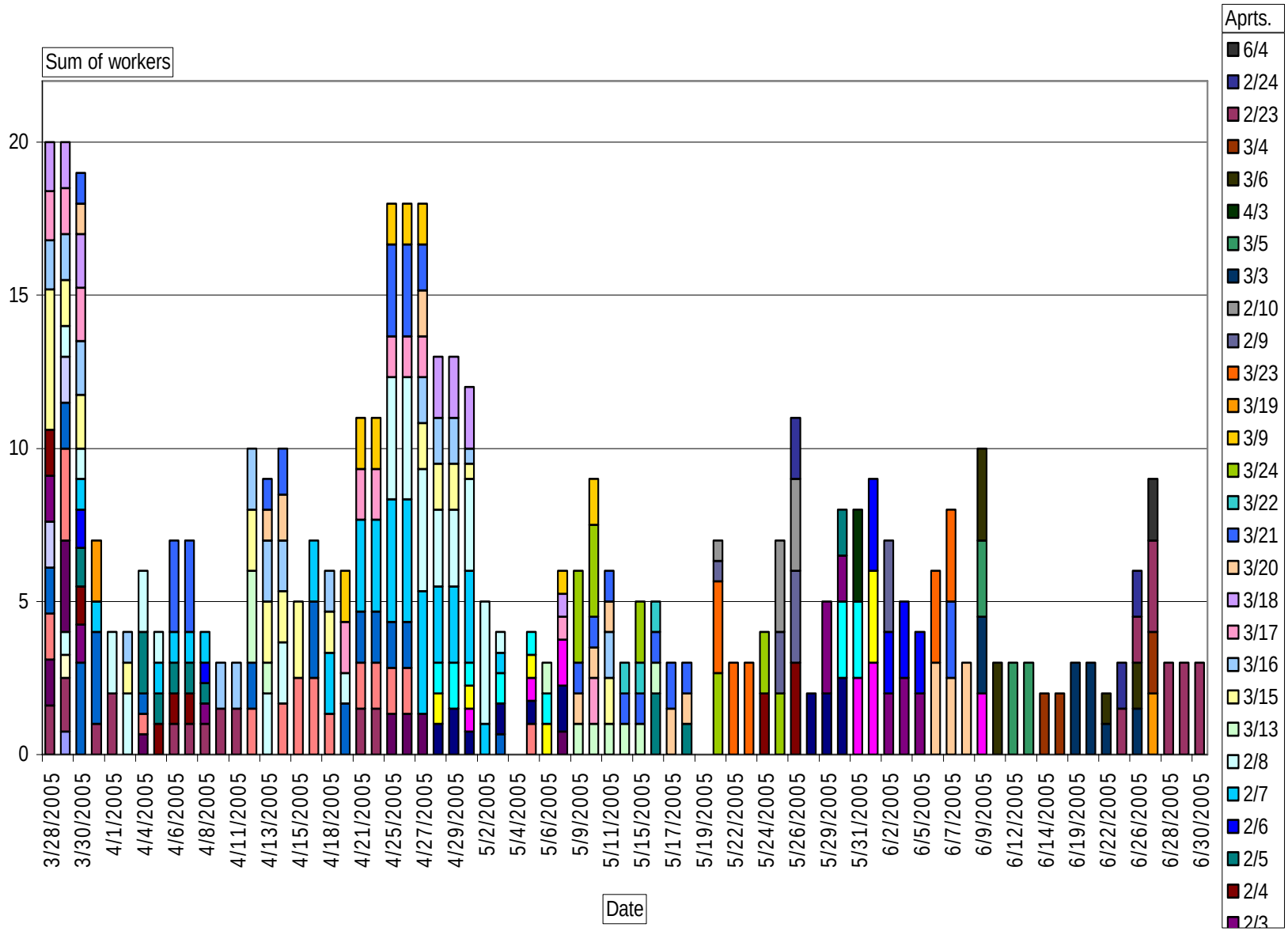
Pull system

Kaizen - continuous improvement

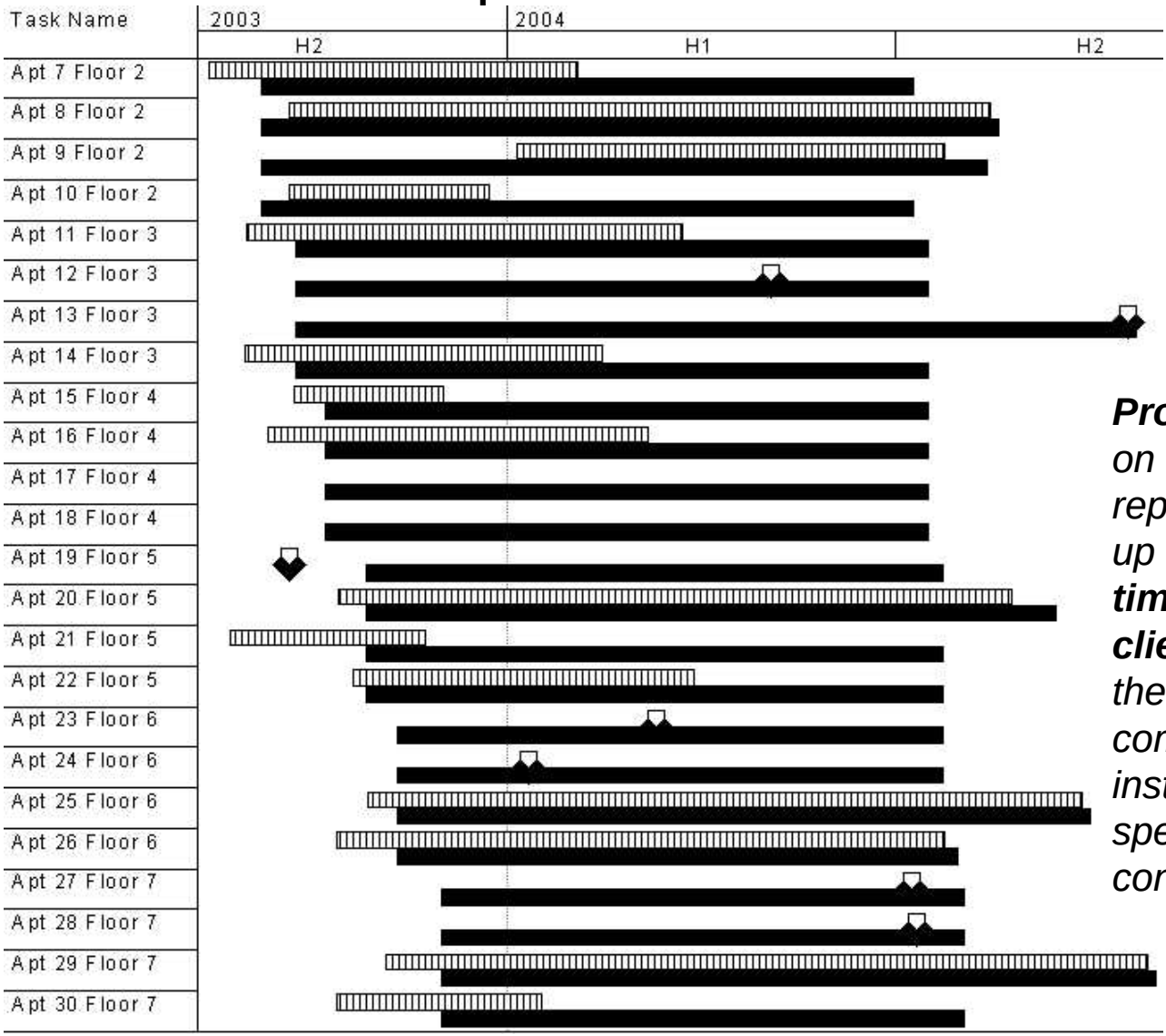
Stability

Standardised work

Variation on site



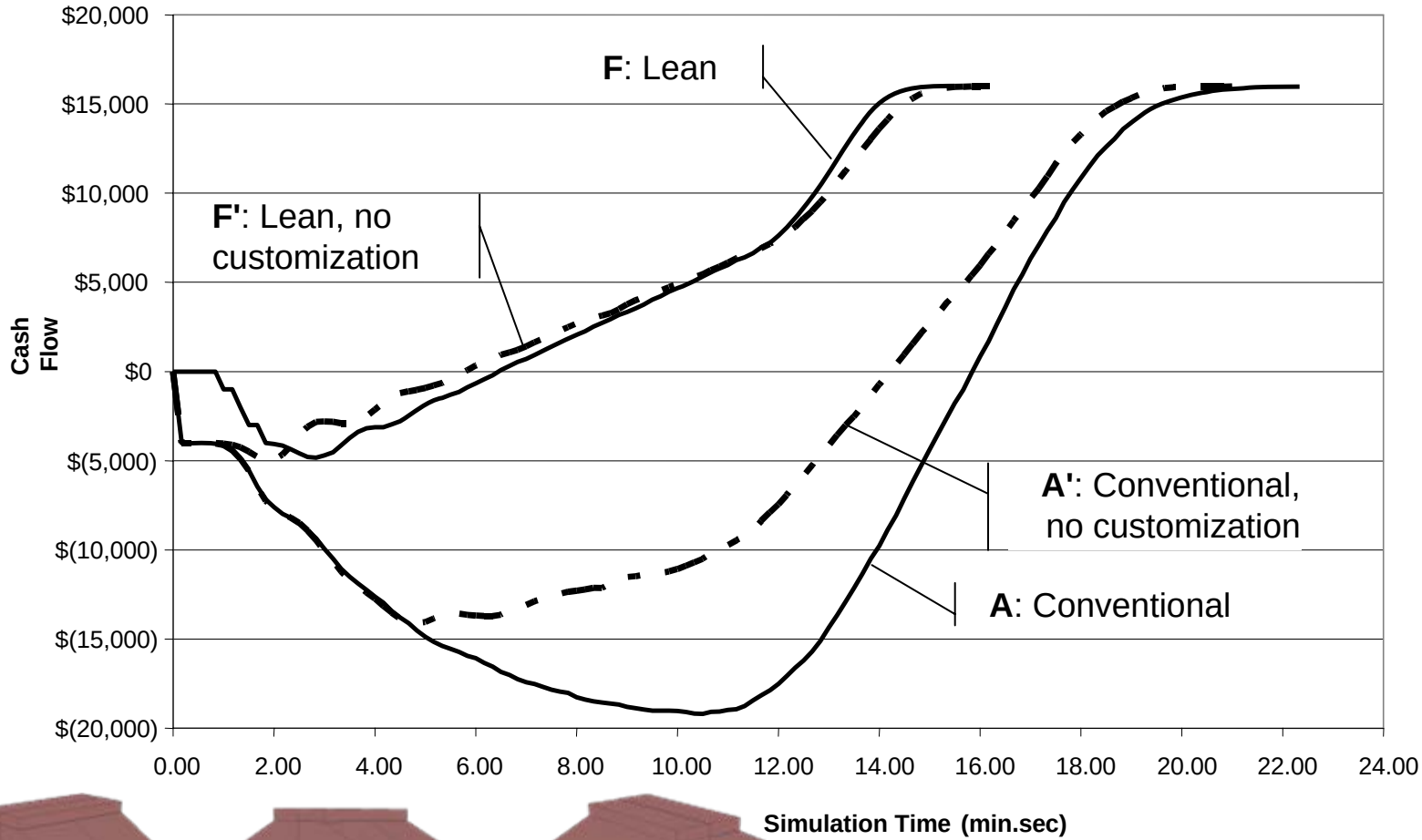
Impact of Variation

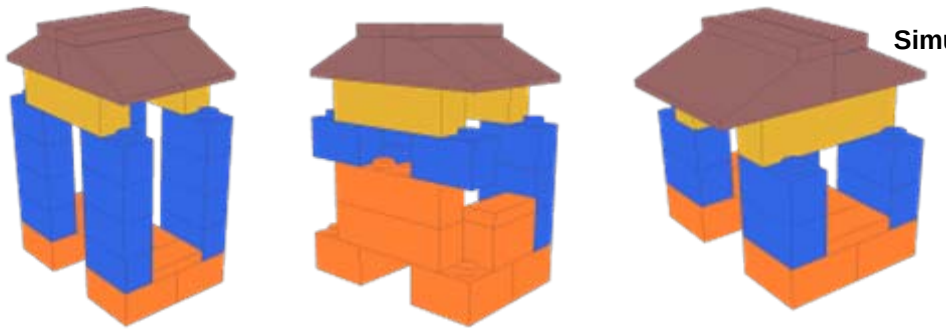


Project managers *on high-end projects reported spending up to* ***60% of their time managing client changes*** *and the resulting complexity of instructions to specialty contractors.*

Sacks, R., and **Goldin, M.,** (2007). '[Lean Management Model for Construction of High-rise Apartment Buildings](), ASCE Journal of Construction Engineering and Management, Vol. 133 No. 5 pp. 374-384

LEAPCON Cash Flows





LEAPCON Simulation

www.technion.ac.il/~cvsacks/tech-leap.htm

Building Information Modeling

Building Information Modeling (BIM)

- **Tools, processes and technologies that are facilitated by digital, machine-readable documentation about a building, its performance, its planning, its construction and later its operation**.

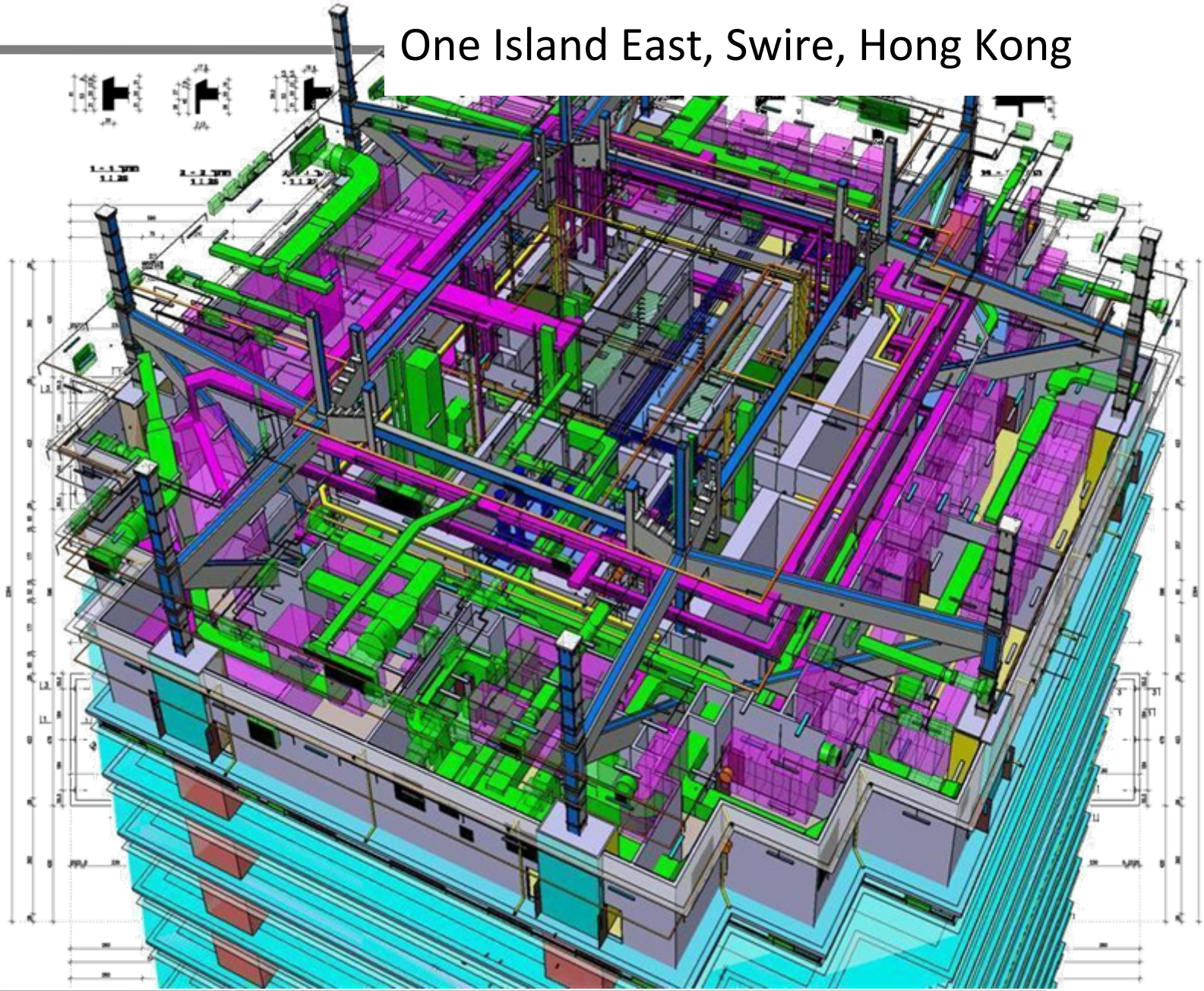
Therefore BIM describes an activity, not an object. To describe the result of the modeling activity, we use the term 'Building Information Model', or more simply 'Building Model' in full.

Building Model

- **A digital, machine-readable record of a building, its performance, its planning, its construction and later its operation.**

A Revit® model or a Digital Project™ model of a building are examples of Building Models. 'Building Model' can be considered the next-generation replacement for 'construction drawings', or 'architectural drawings'.

One Island East, Swire, Hong Kong

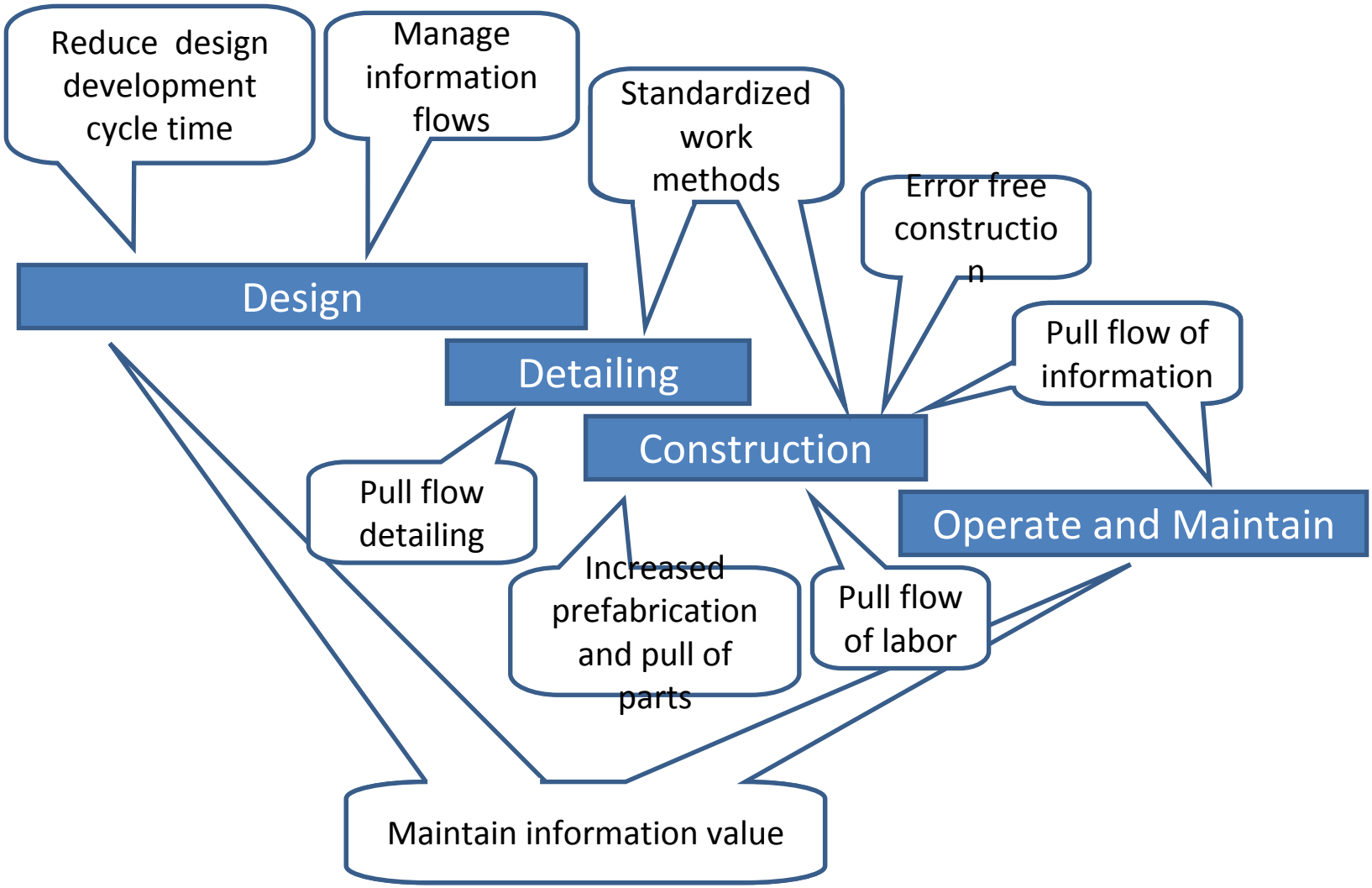


Owner

BIM Benefits

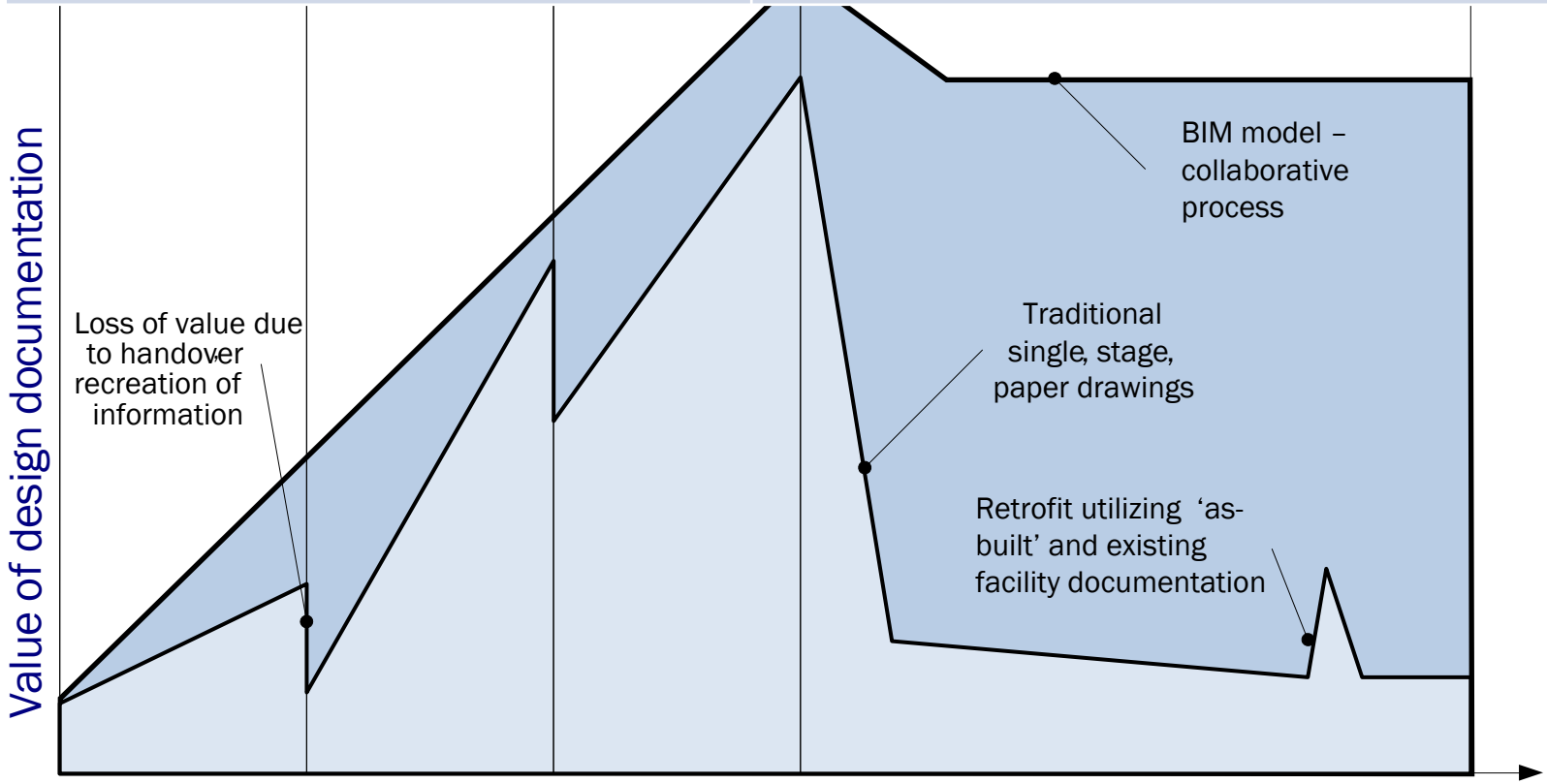
Benefit	Description
Productivity	Reduce design and engineering labor
Quality	Prevent design and coordination errors
Duration	Shorten design duration
Accuracy	Heighten accuracy for all analyses
Industrialization	Produce detailed fabrication data, increase preassembly and prefabrication
Management	Improve information flow

Lean and BIM Synergies



Maintain Information Value

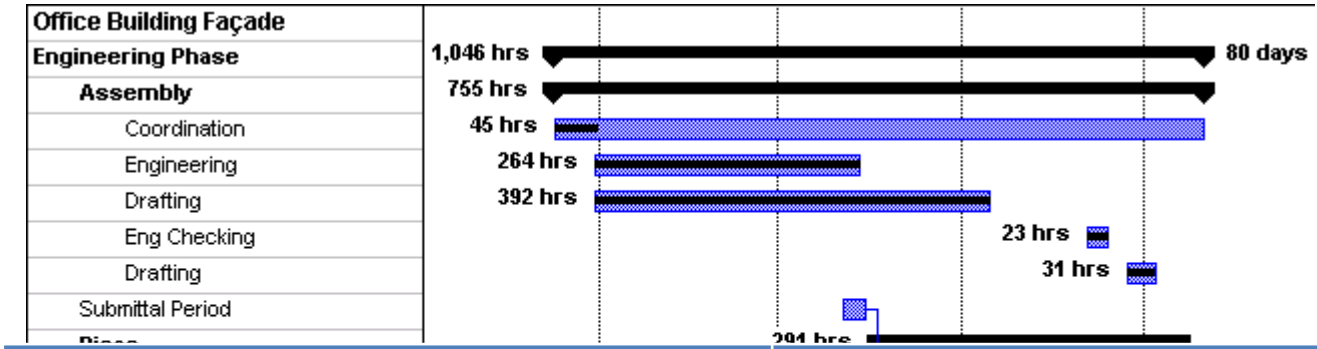
Lean construction need	BIM facility
Maximize **Value** to Client	Re-use of model information



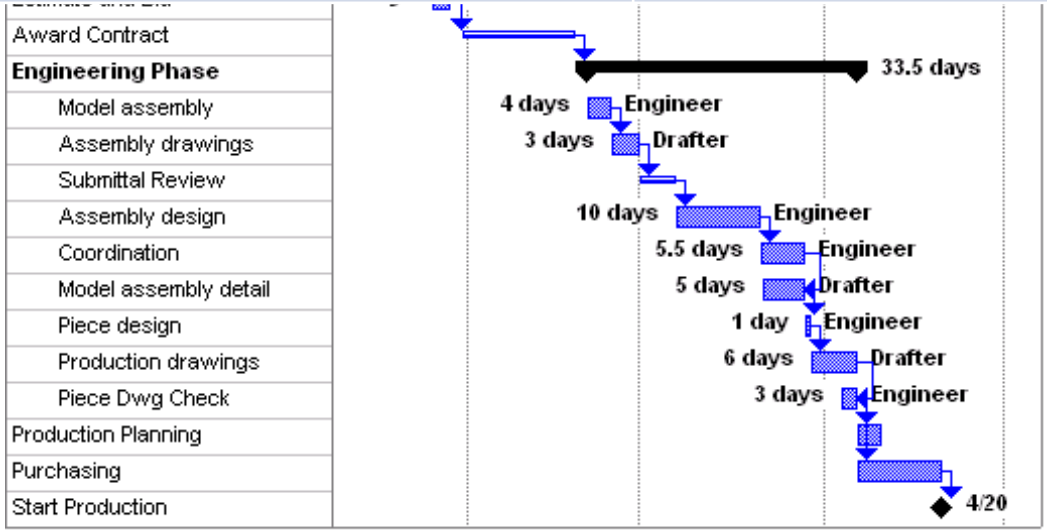
BIM Handbook, Eastman et al. 2008, John Wiley and Sons.

Value

Reduce Design Cycle Time



Lean construction need	BIM facility
Reduce **Cycle Time**	Review model instead of drawings, automatic drawing production

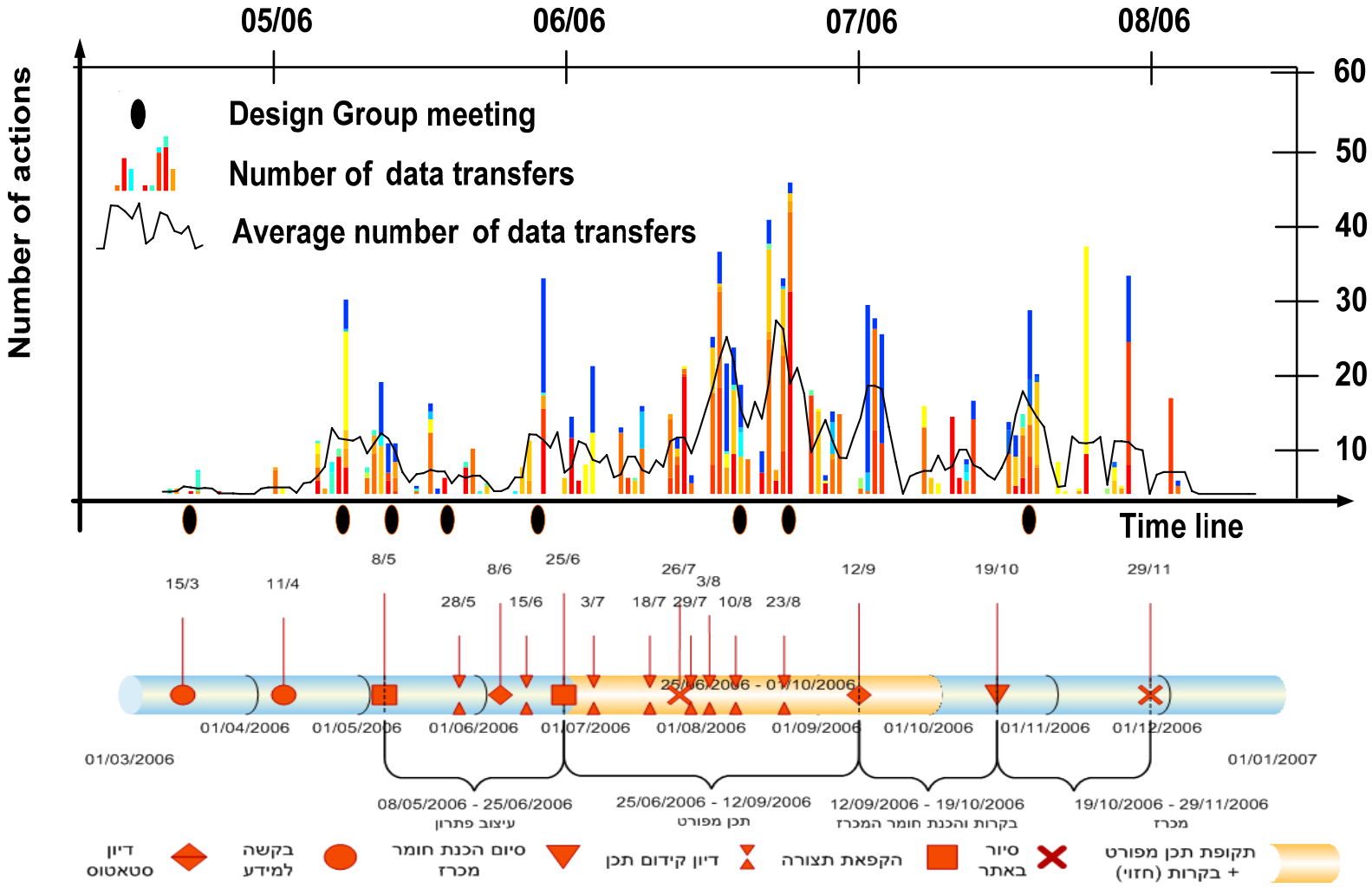


34 days

Cycle Time

Sacks, R., (2004), '[Evaluation of the economic impact of computer-integration in precast concrete construction]', ASCE Journal of Computing in Civil Engineering, Vol. 18 No. 4. pp. 301-312.

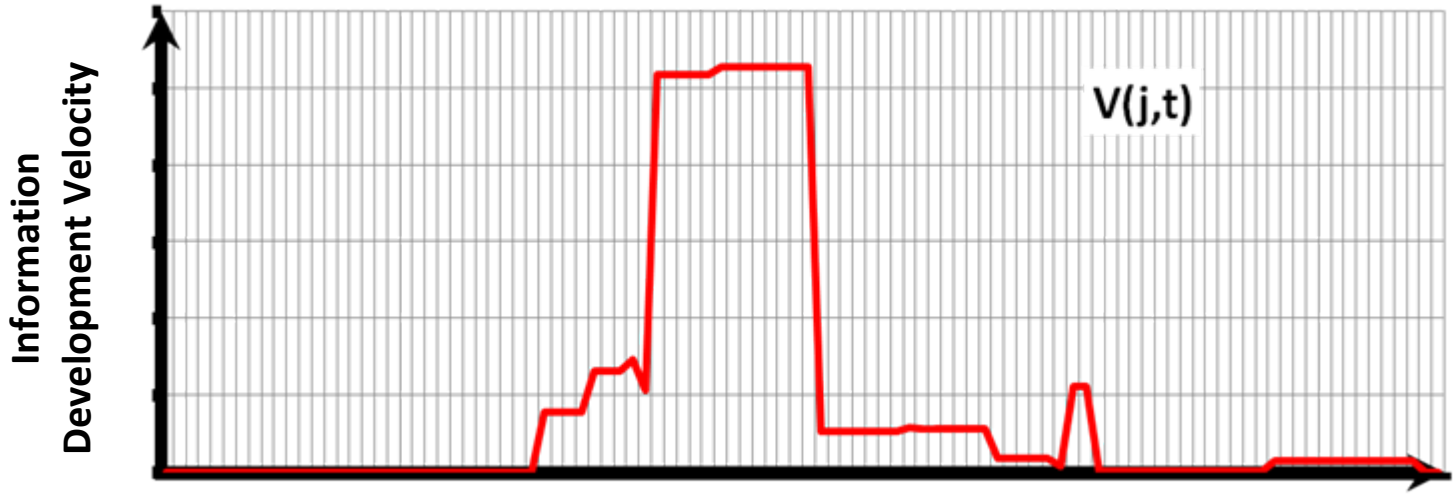
Manage Design Information Flow

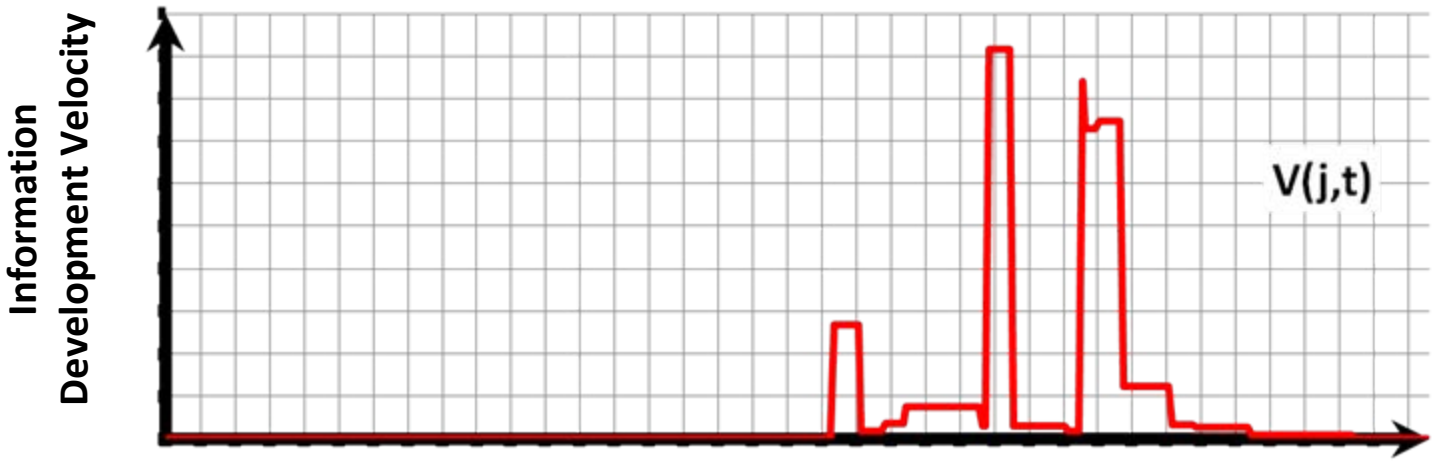


Continuous Flow

Information Development Velocity

Using project extranets with building models:



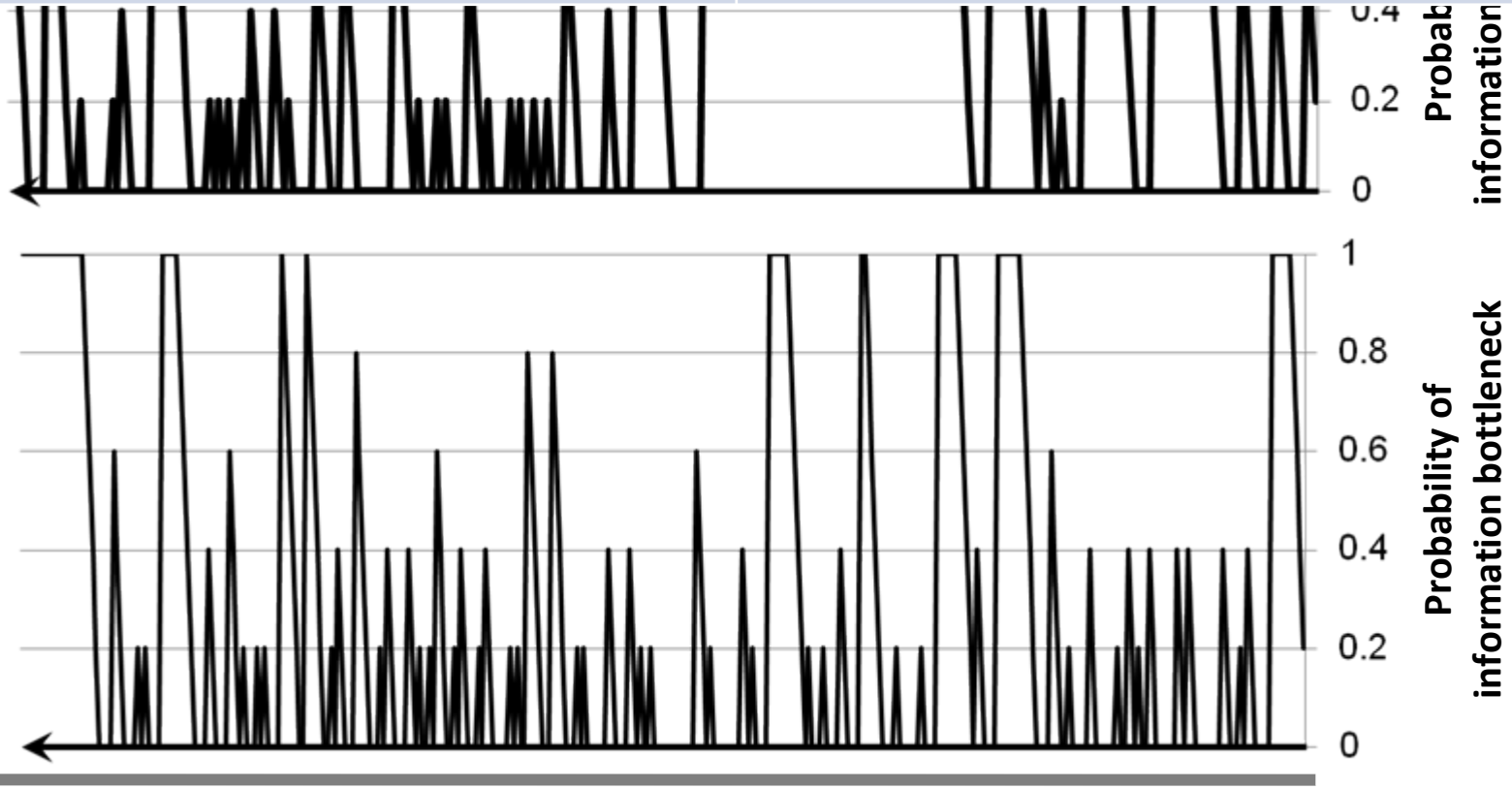


Continuous Flow

Probability of Bottleneck

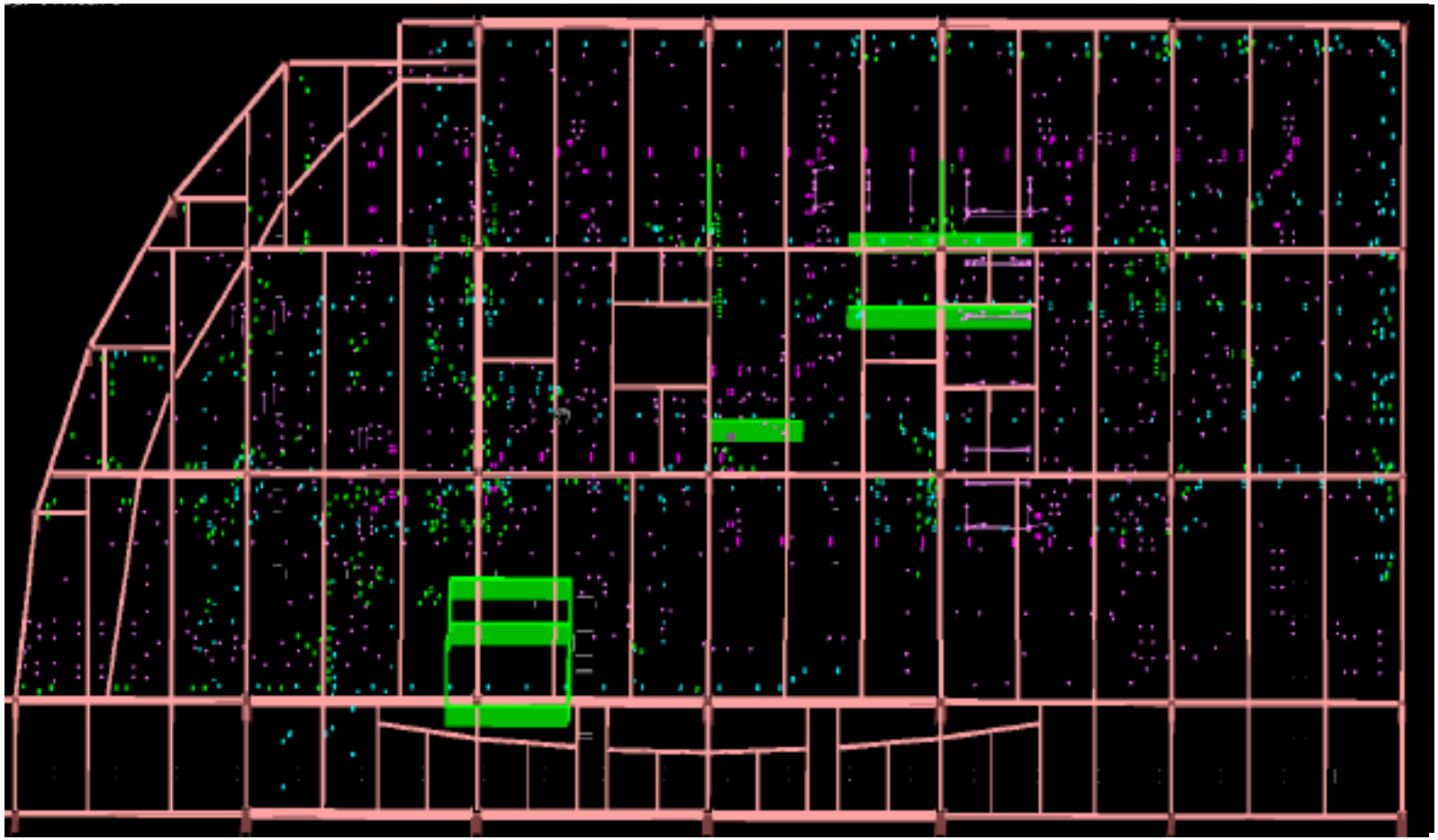
Using project extranets:

Lean construction need	IT and BIM facility
Visualization of flow – design	Monitoring of design information flow using BIM and model servers or project intranets



Continuous Flow

Pulling Detailing Information



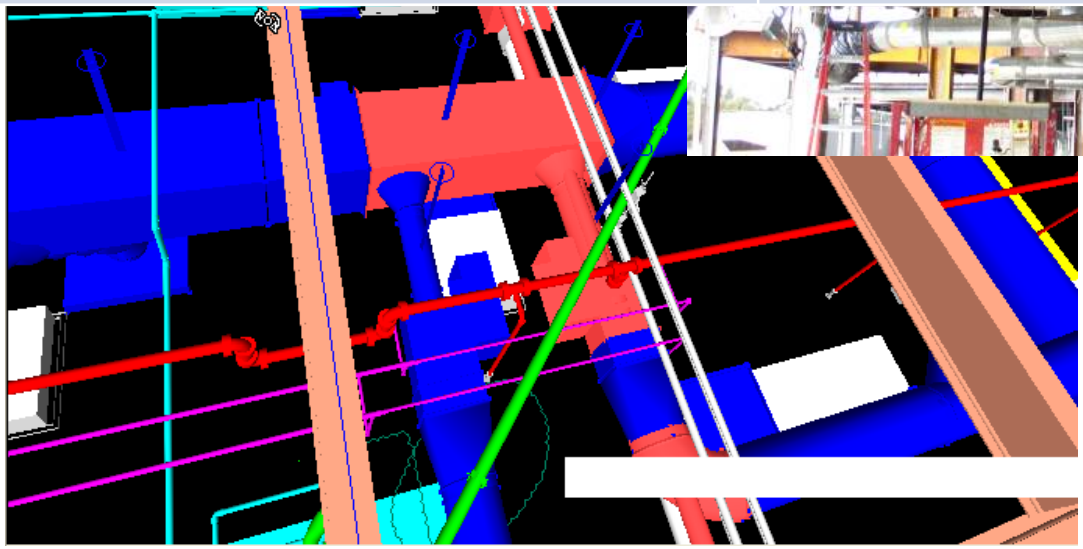
4D Simulation; Set sequence priority (e.g. walls for medium pressure duct); pull detailing work only when construction approache

Pull flow

DPR Construction Inc.

Pulling Detailing Information

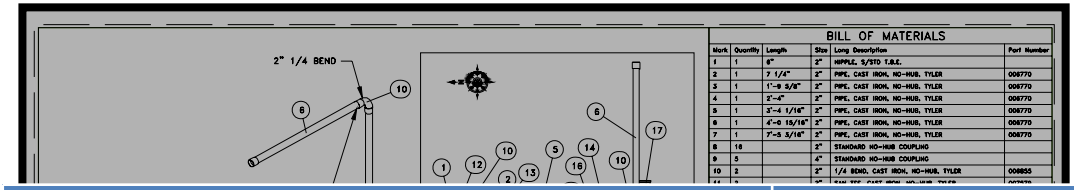
Lean construction need	BIM facility
Pull detailing and fabrication/assembly of building system components according to short term plans	**Collaborative detailing** with integration across disciplines, automated clash checking



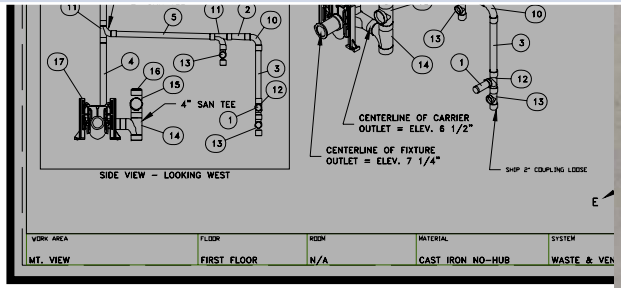
Clash checking

Pull flow Collaborative Design

Standardized Work



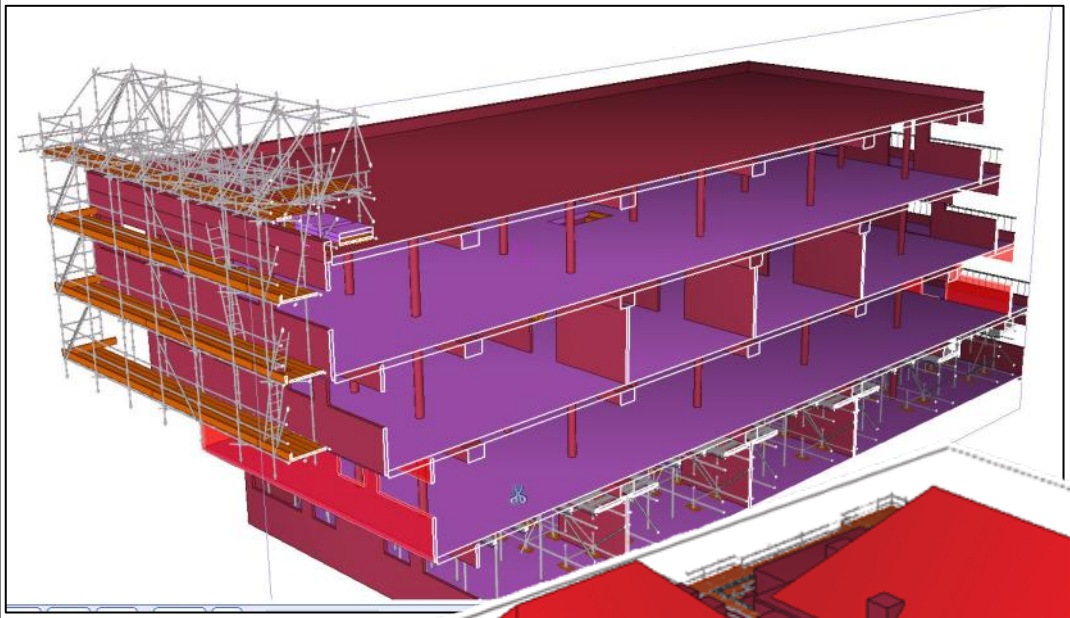
Lean construction need	BIM facility
Standardised work	Automated assembly instructions and bills of material

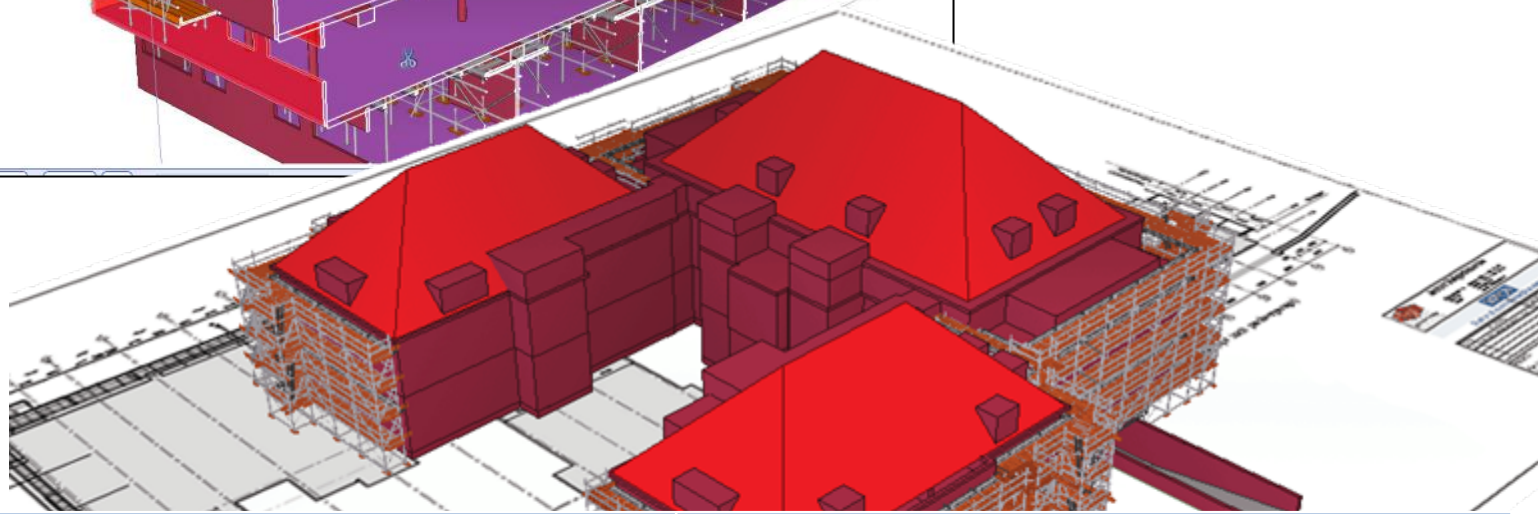


1. Drawings for each work package generated automatically from the model;
2. Parts fabricated and packaged off-site;
3. Installed on site as a package

Standardised Work

4D Modeling, Temporary Facilities



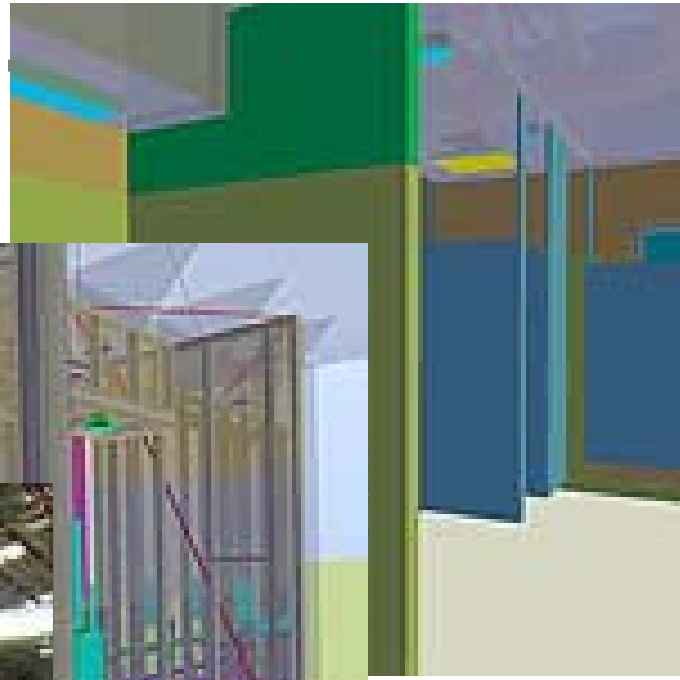


Lean construction need	BIM facility
Stable work - effective project planning, predicting problems, avoiding problems	4D animation and modeling of temporary process facilities, error-free design and detailing

Error free stable work

Increased Prefabrication



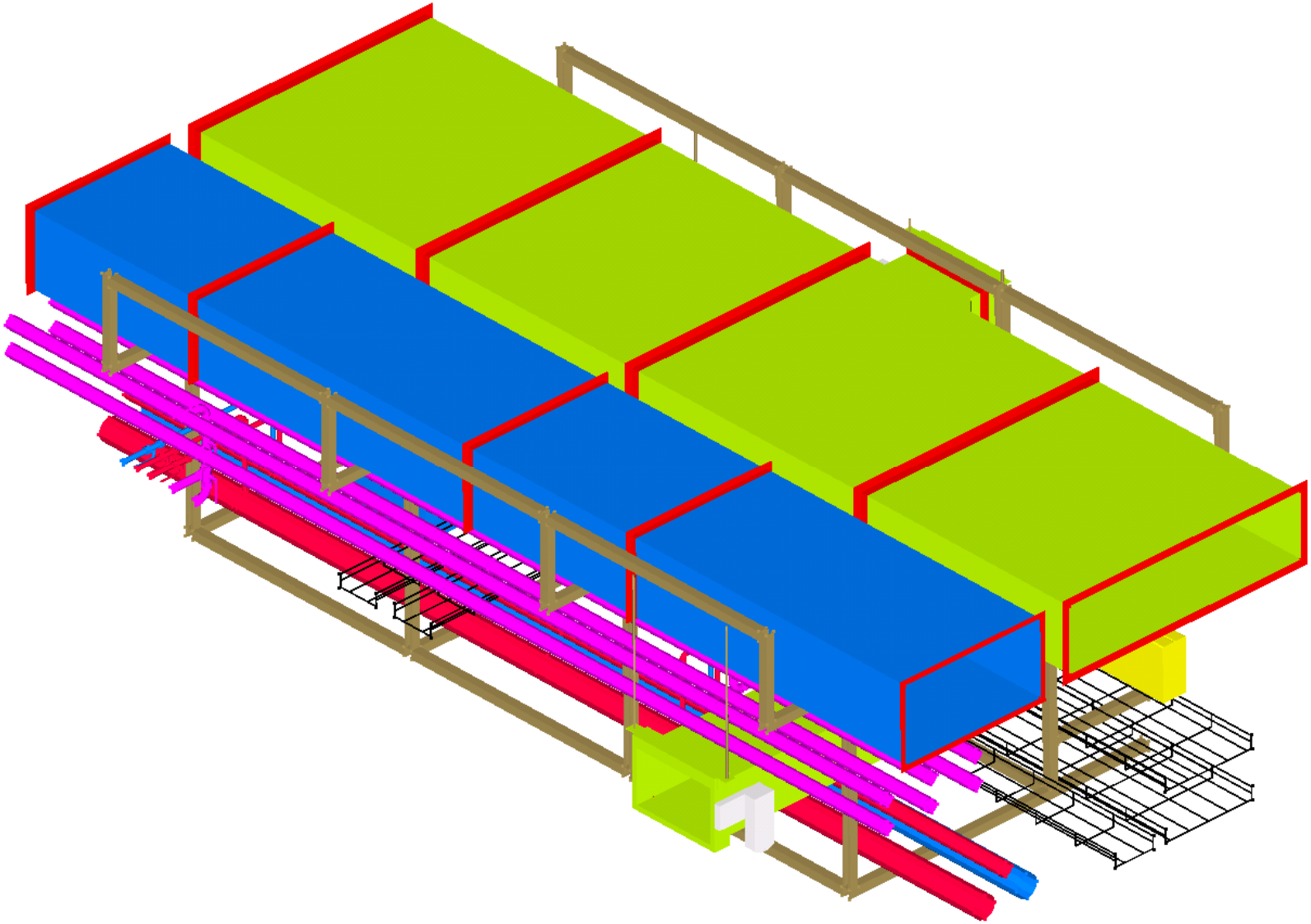
ARCHITECTUREWEEK

Campbell, Architecture Week 2006

Remove Waste

Quality

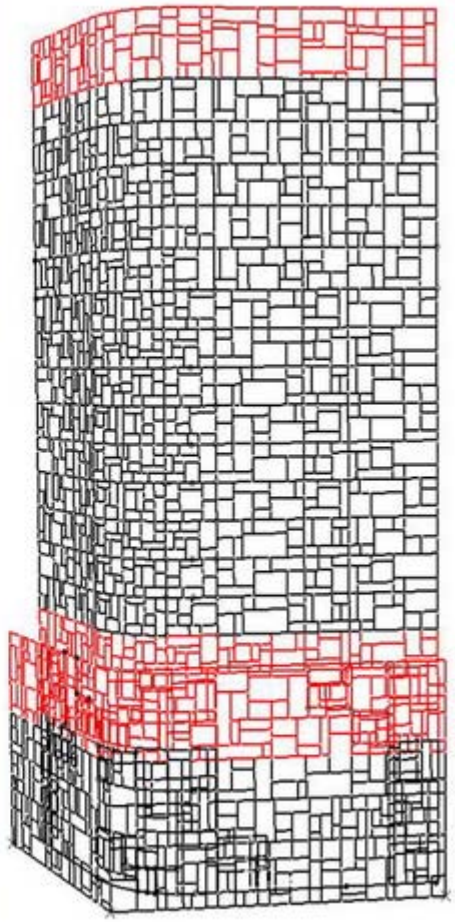
Increased Prefabrication



Remove Waste

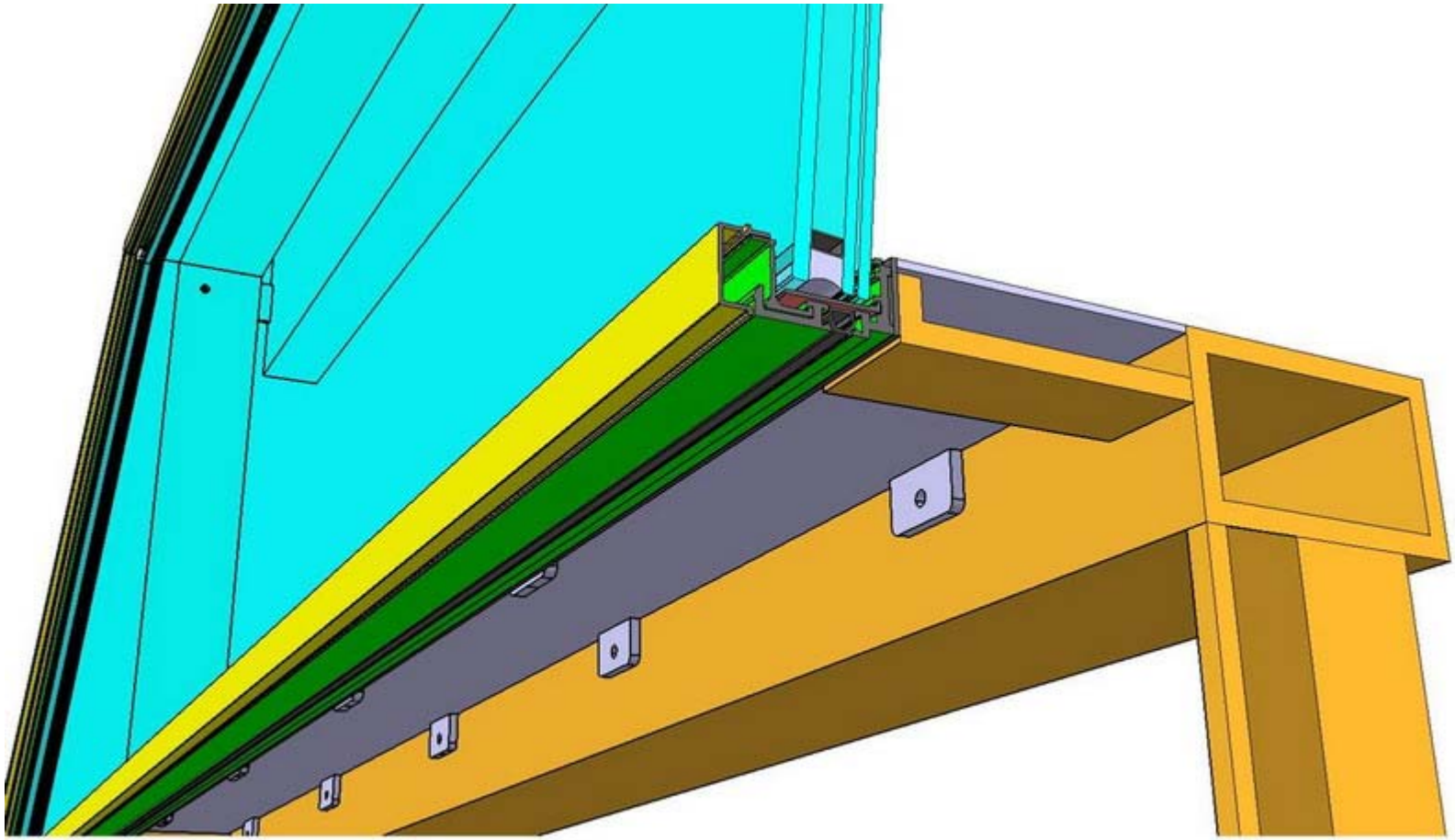
Quality

Increased Prefabrication



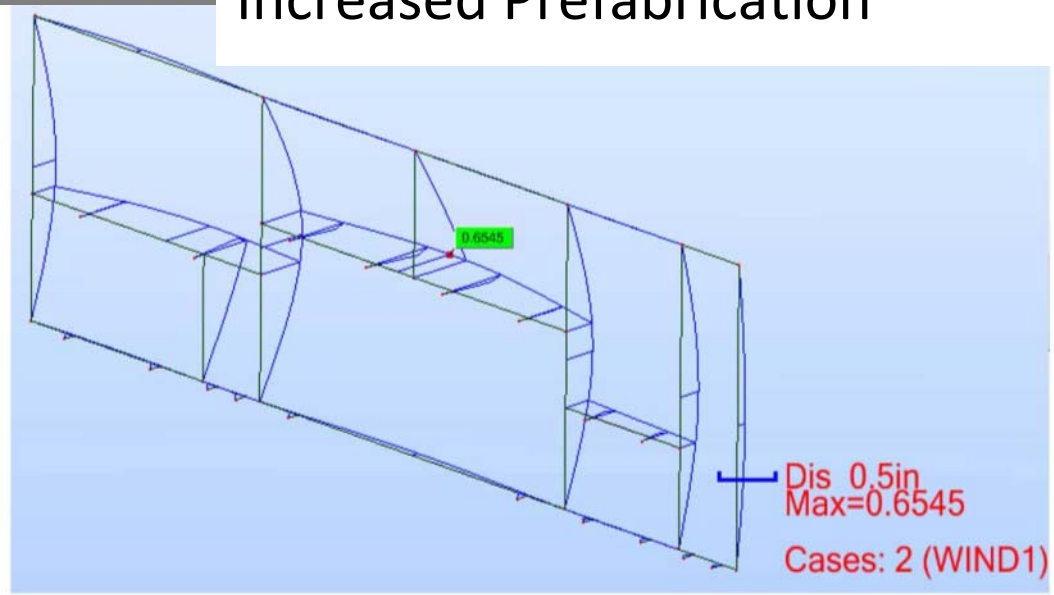
Remove Waste

Increased Prefabrication

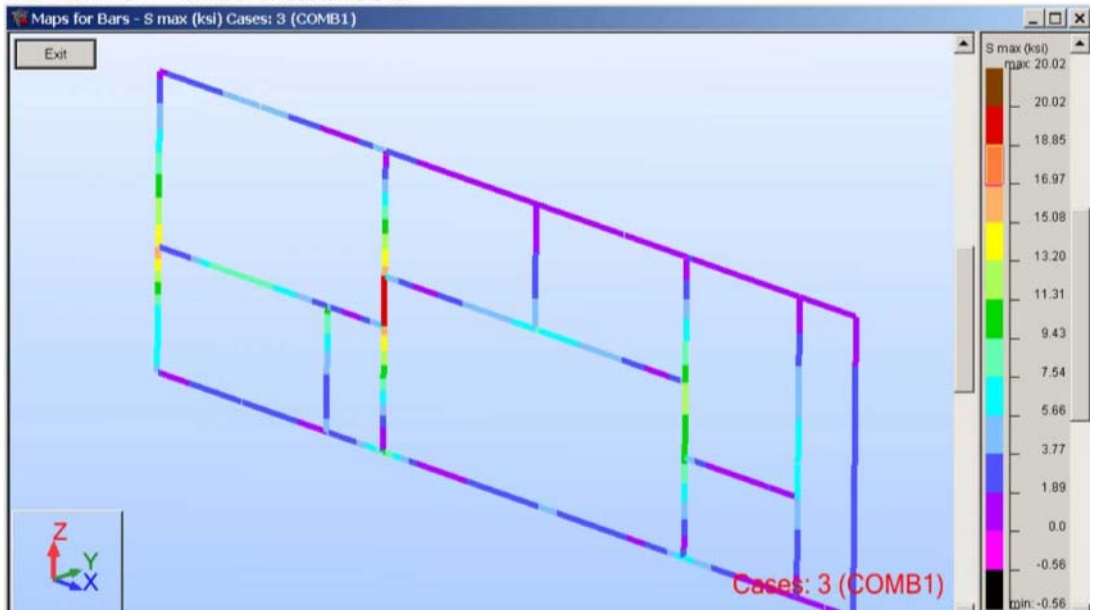


Remove Waste

Increased Prefabrication

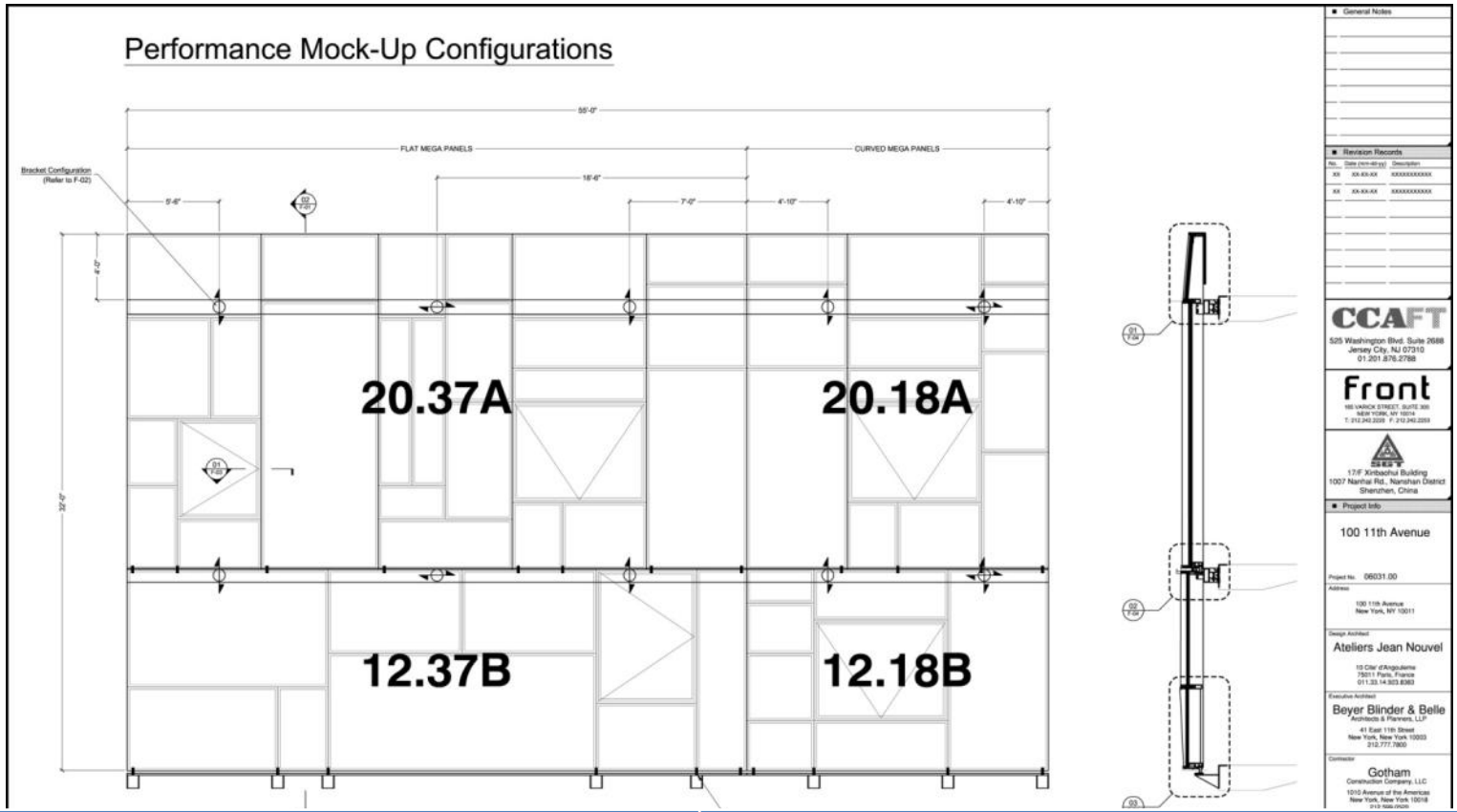


The maximum member stress is 20.0ksi



Remove Waste

Increased Prefabrication

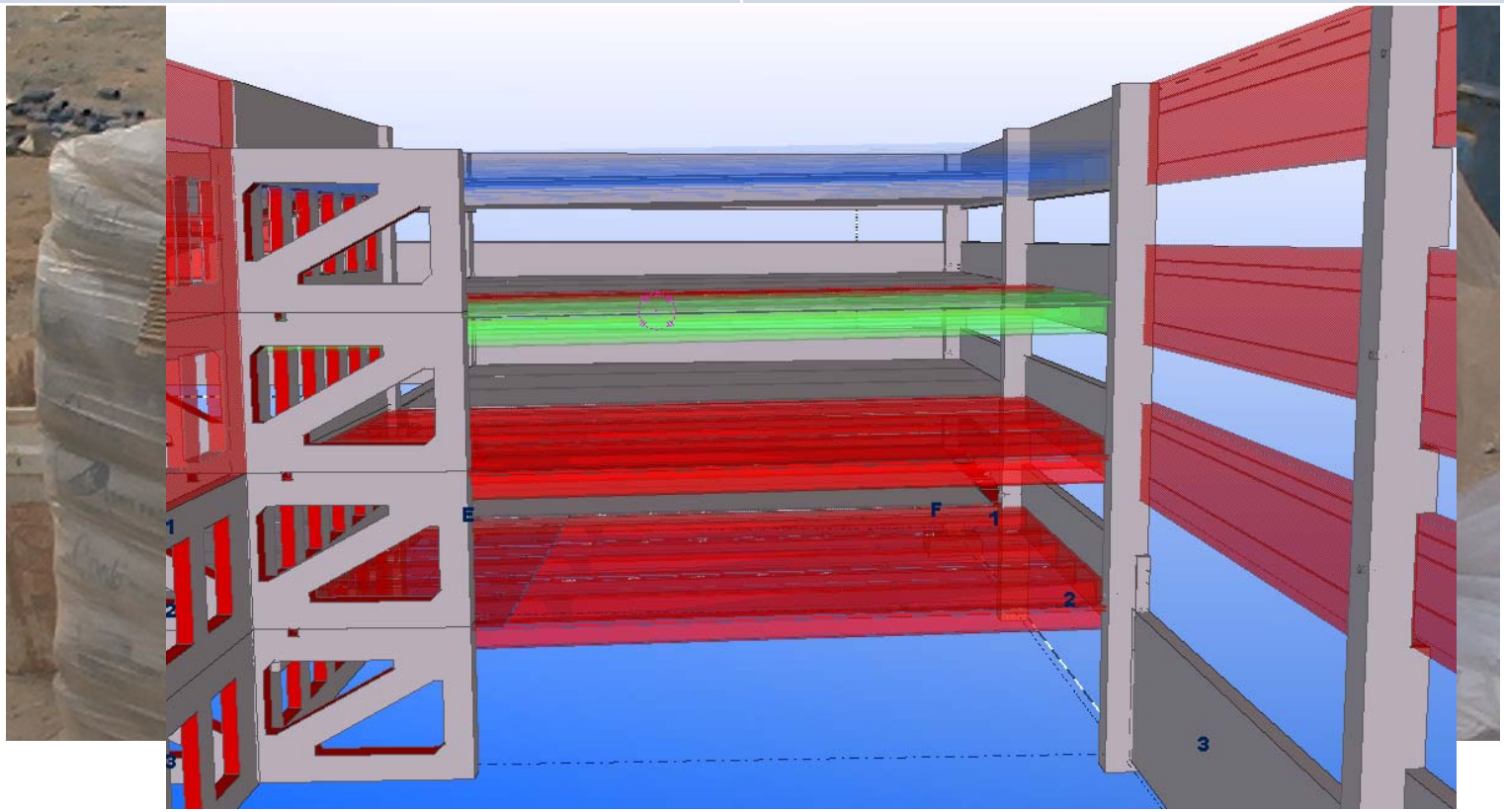


Lean construction need	BIM facility
Prefabrication – remove waste of unnecessary or inefficient activities	Accurate error-free detailing for prefabrication

Remove Waste

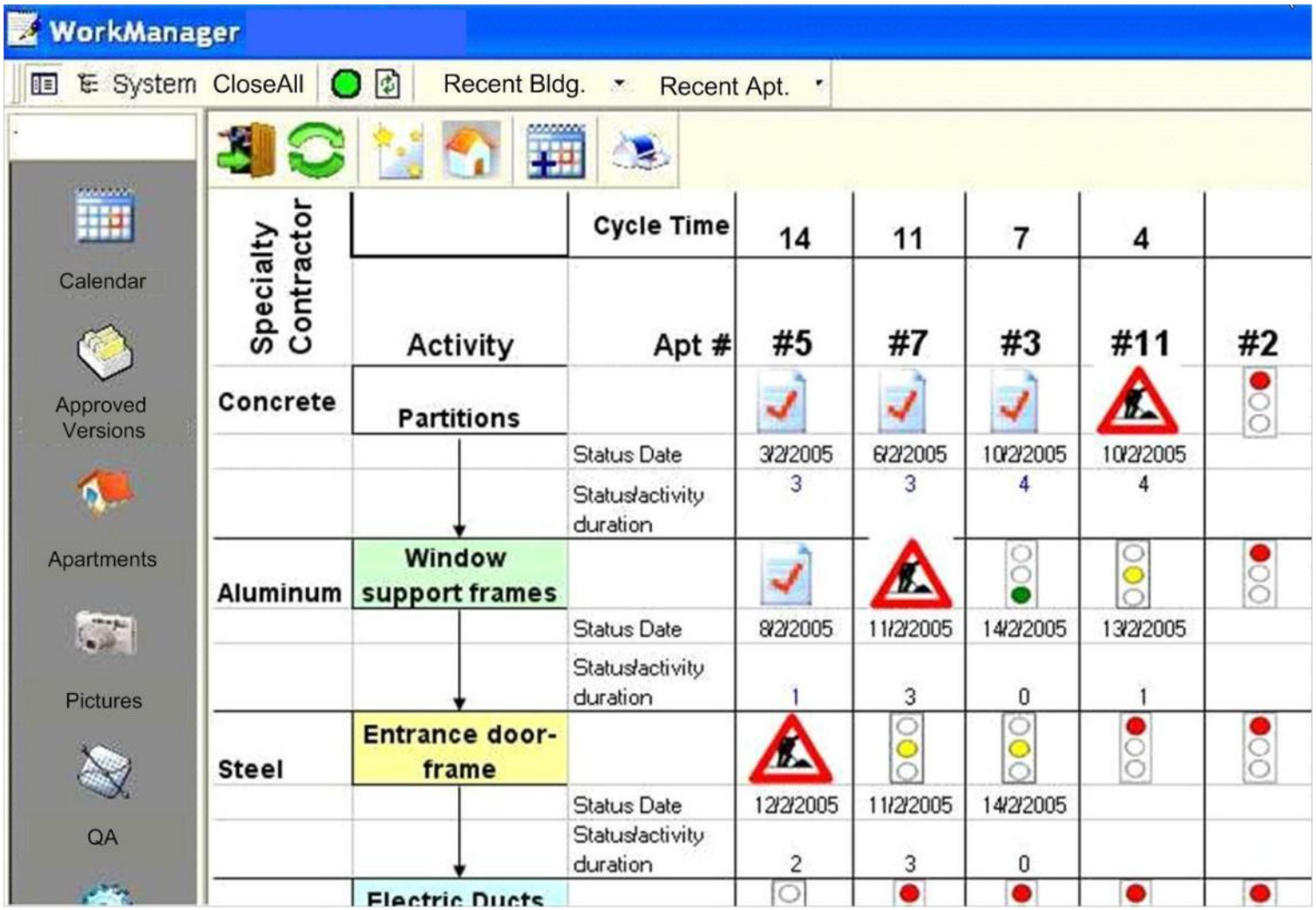
Pulling prefabricated parts

Lean construction need	IT and BIM facility
Pull of materials and Kanban signals for fabrication	On-line pull of materials and signals through management information linked through a BIM server



Pull flow

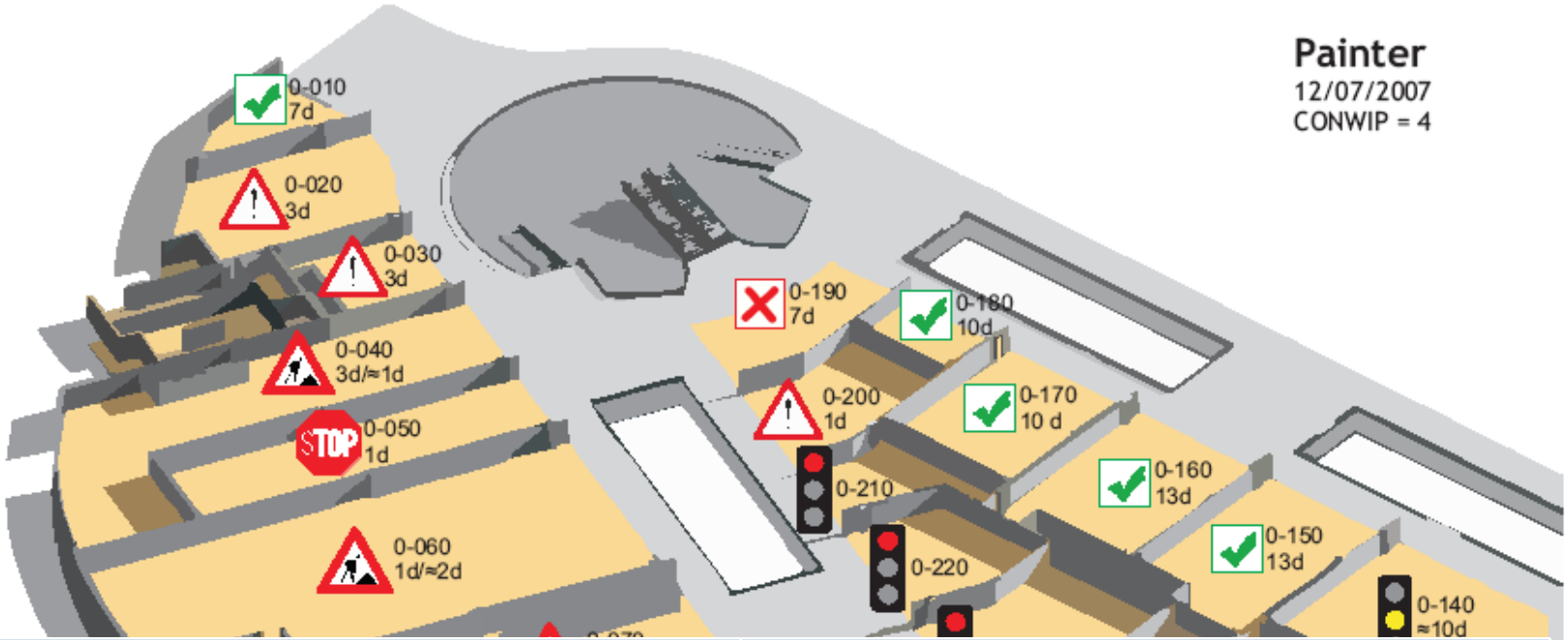
Pulling Labor and Visualizing Status



Specialty Contractor	Activity	Apt #	Cycle Time	14	11	7	4	
				#5	#7	#3	#11	#2
Concrete	Partitions							
			Status Date	3/2/2005	6/2/2005	10/2/2005	10/2/2005	
			Status\activity duration	3	3	4	4	
Aluminum	Window support frames							
			Status Date	8/2/2005	11/2/2005	14/2/2005	13/2/2005	
			Status\activity duration	1	3	0	1	
Steel	Entrance door-frame							
			Status Date	12/2/2005	11/2/2005	14/2/2005		
			Status\activity duration	2	3	0		
	Electric Ducts							

Pull flow

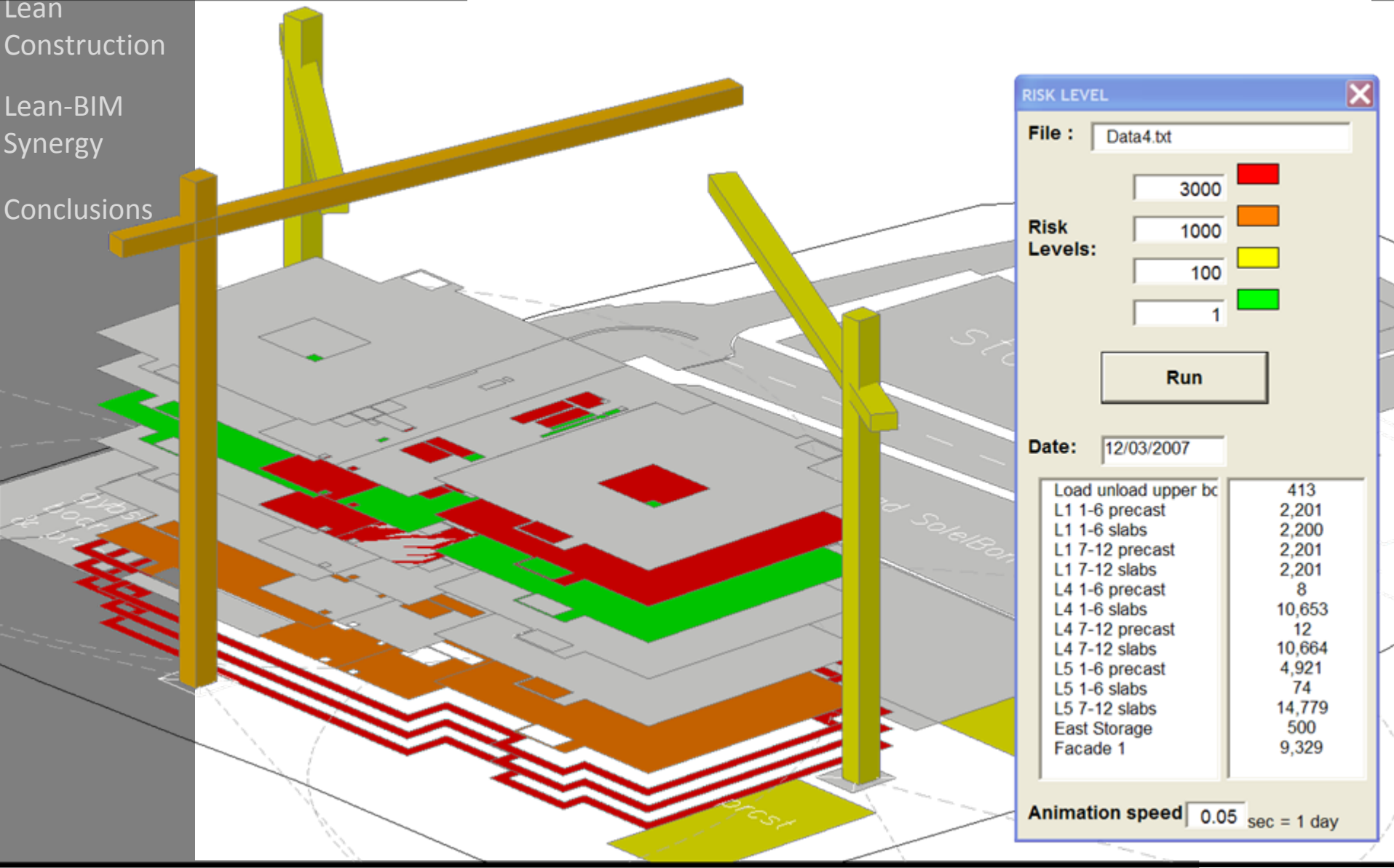
Pulling Labor and Visualizing Status

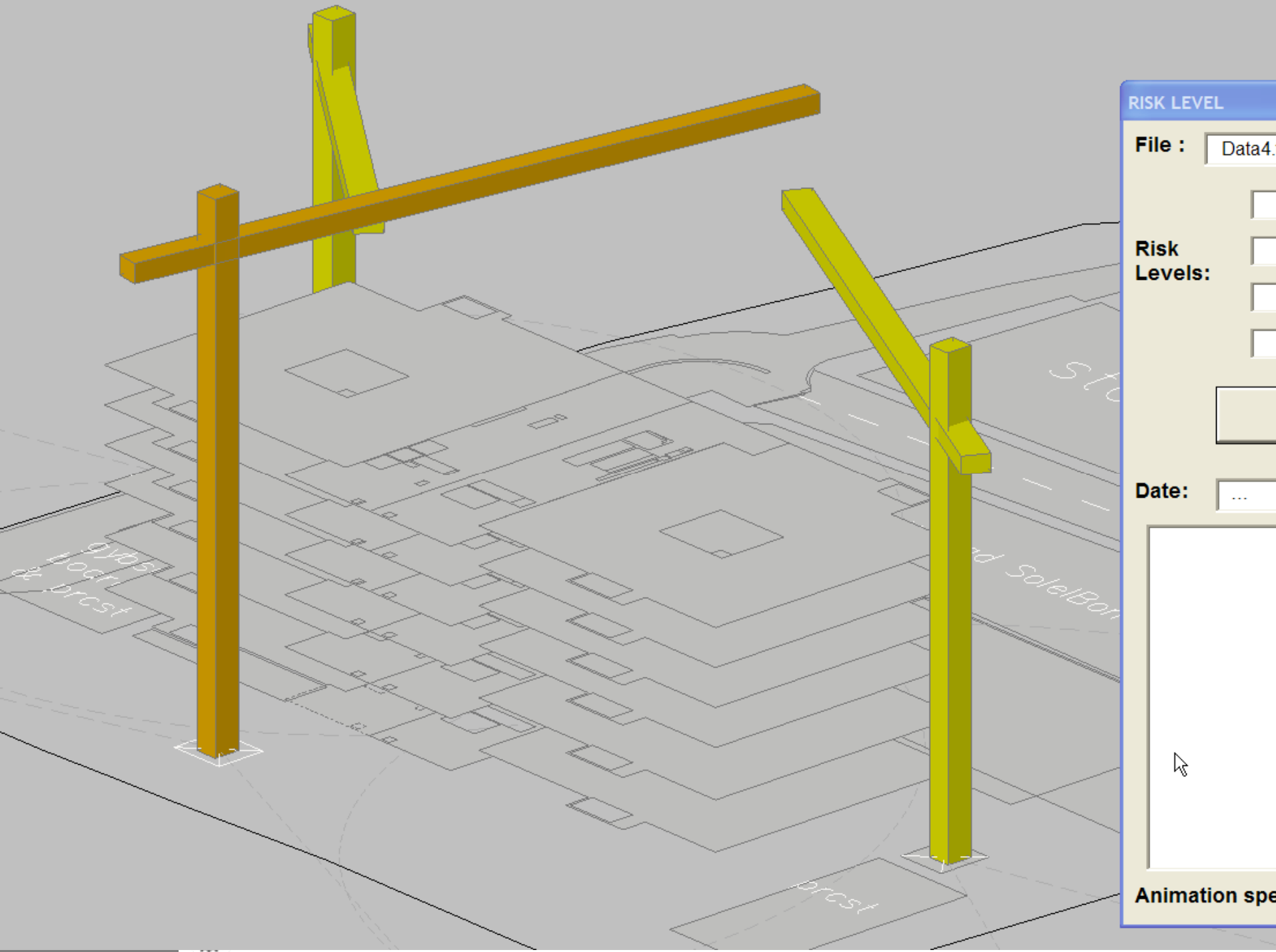


Lean construction need	BIM facility
Pull flow signals are not visible, like in manufacturing, so directives to teams pull work	On-line pull flow signals can be communicated to teams online
Project status **changes** rapidly and sometimes unexpectedly. Information is complex, diverse, plentiful and difficult to integrate	Good **visualization** is needed for construction process and work readiness information

Pull flow

Safety – Risk forecast for work planning




RISK LEVEL
File :
Data4
Risk Levels:
Date:
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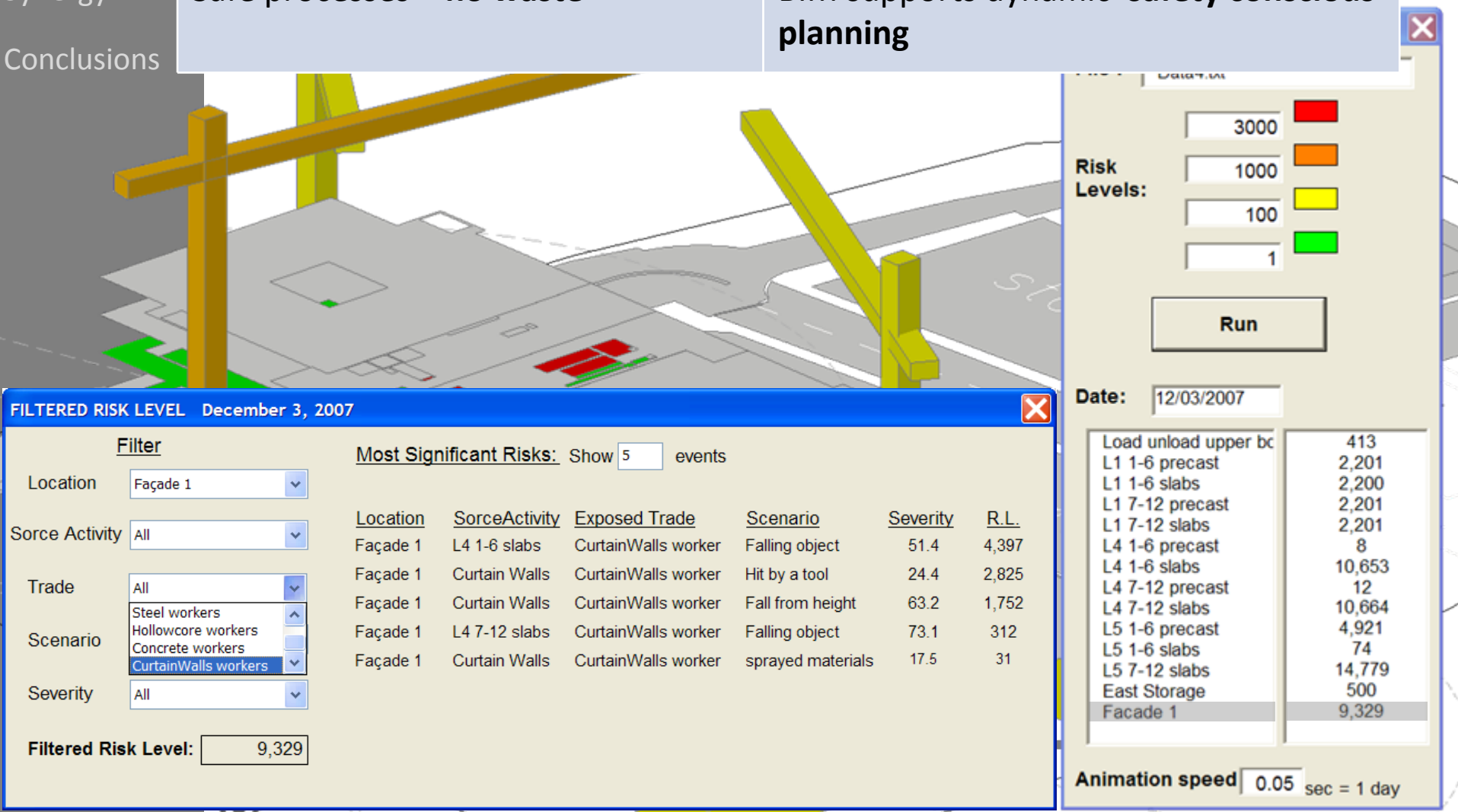
Safety – Risk forecast for work planning

Lean construction need	BIM facility
Safe processes – **no waste**	BIM supports dynamic **safety conscious planning**



Conclusions

- **BIM makes construction leaner** ;
  Lean thinking focuses BIM implementation
- Owners have a unique role to play as leaders of Lean and BIM initiatives
- Lean and BIM can improve an owner's bottom line, but also have a ripple effect across the construction industry

The challenge to all owners, designers, contractors and fabricators:

To perform lean, BIM-enabled projects …..

….worthy of inclusion as best practice case studies in the 2nd edition of the BIM Handbook !!!